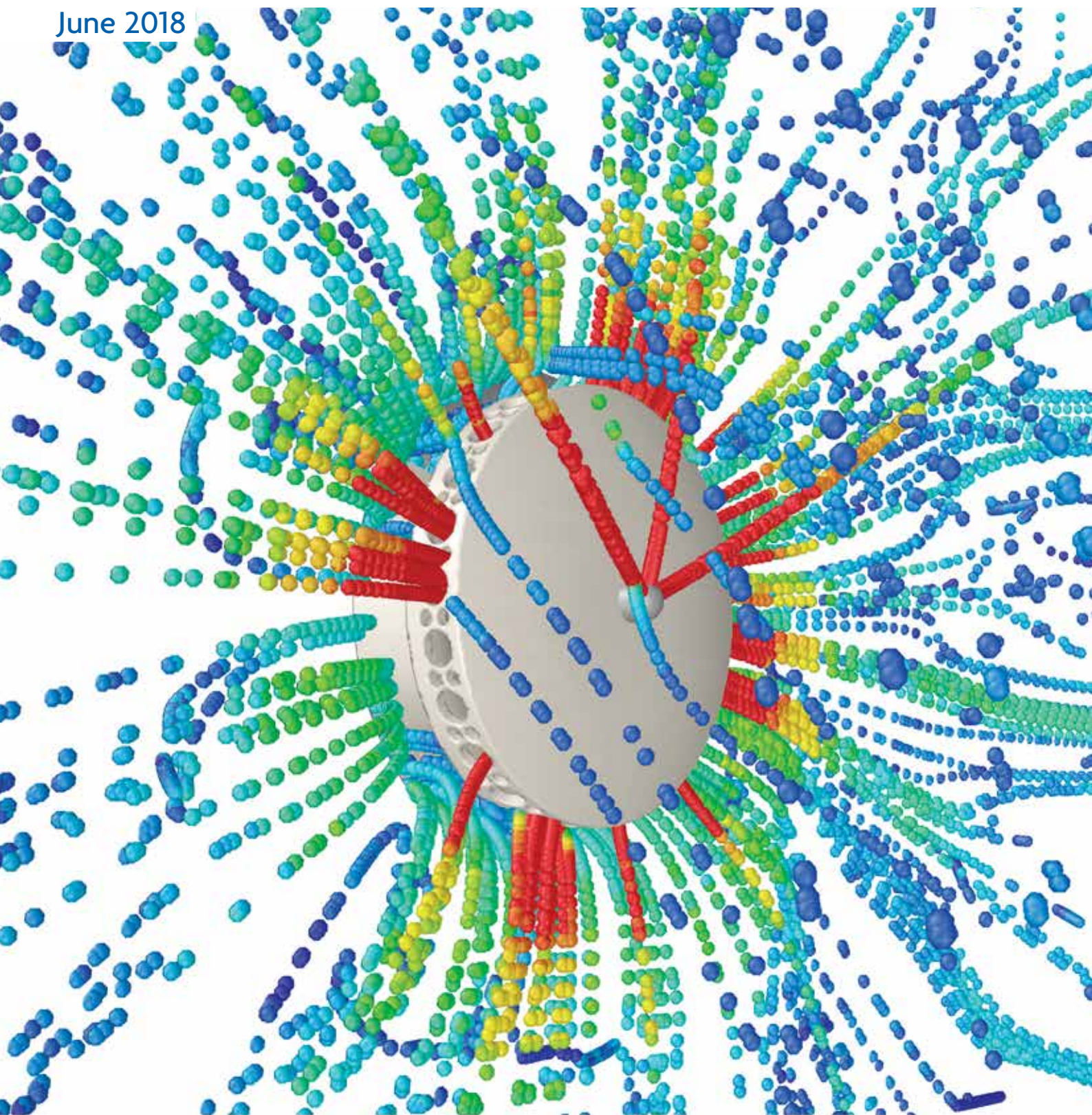


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THIS MONTH'S FRONT COVER



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COMMENT

CONTACT INFO

MANAGING EDITOR James Little
james.little@hydrocarbonengineering.com

EDITOR Callum O'Reilly
callum.oreilly@hydrocarbonengineering.com

ASSISTANT EDITOR Anna Nicklin
anna.nicklin@hydrocarbonengineering.com

ADVERTISEMENT DIRECTOR Rod Hardy
rod.hardy@hydrocarbonengineering.com

ADVERTISEMENT MANAGER Chris Atkin
chris.atkin@hydrocarbonengineering.com

ADVERTISEMENT EXECUTIVE Sophie Barrett
sophie.barrett@hydrocarbonengineering.com

PRODUCTION Ben Munro
ben.munro@hydrocarbonengineering.com

WEB MANAGER Tom Fullerton
tom.fullerton@hydrocarbonengineering.com

DIGITAL EDITORIAL ASSISTANT Nicholas Woodroof
nicholas.woodroof@hydrocarbonengineering.com

SUBSCRIPTIONS Laura White
laura.white@hydrocarbonengineering.com

ADMINISTRATION Nicola Fuller
nicola.fuller@hydrocarbonengineering.com

CONTRIBUTING EDITORS
Nancy Yamaguchi Gordon Cope

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Palladian Publications 

15 South Street, Farnham, Surrey
GU9 7QU, ENGLAND
Tel: +44 (0) 1252 718 999
Fax: +44 (0) 1252 718 992

**HYDROCARBON
ENGINEERING**



CALLUM O'REILLY
EDITOR

World Cup fever has well and truly gripped our office in recent weeks. *Hydrocarbon Engineering's* Assistant Editor, Anna, has already stuck a giant World Cup fixture planner next to her desk, bought an England horn, and is threatening to attach St George's Cross flags to

our car when we make the trip over to Germany forACHEMA in June (if you're attending the show, please drop by Hall 9.2, Stand D1 to meet the team).

Prior to England announcing its 23-man squad to take on the world in Russia, the British media went into overdrive with editorial pieces outlining why certain players should (and shouldn't) be selected for the tournament. Amongst the more interesting of these stories were those that compiled squads based on performance data from the previous season alone. These pieces dug deep into the data behind every player eligible to play for England at the tournament, analysing statistics such as number of appearances, pass accuracy, distance covered per game, number of tackles, chances created and shooting accuracy.

While the final squad did not exactly mirror the statistics, data is undoubtedly playing an increasingly important role in all sports. Innovative technology can now provide teams with intricate data about their staff's performance, which can be used to tailor a player's workload and fine-tune their training programmes.

Much has been written about the transformative impact of digitalisation on the oil and gas industry. Companies are embracing technologies such as the Cloud, artificial intelligence, virtual reality, big data and analytics to help optimise performance, improve efficiency and lower costs. Another benefit of the digital revolution is that companies can develop deeper relationships with their customers.

Many of these benefits are demonstrated in an online competition recently launched by NAPCON, which is rather aptly named the '2018 Operator World Cup'. The competition will be played with NAPCON's simulation-based Furnace operator training game, which teaches the player how to operate an industrial furnace. The competition, which started in May, involves online qualifications. The most successful players are then chosen to participate in industry events, where they will play against each other, face-to-face. The three best players in each month will receive five licenses to NAPCON's Furnace game, as well as its Distiller game, which was developed to train process operators in the basic distillation process within an oil refinery.

Initiatives such as NAPCON's Operator World Cup are good examples of how companies can use digitalisation to successfully interact with their customers, while demonstrating the benefits of their technology and capturing vital data about their users. Crucially, gamification, in a world of big data, also enables those customers to engage their workforce during operator training and monitor their performance.

Although it's difficult to imagine that any amount of data will help England win the World Cup this summer, I'm keeping my fingers-crossed that the team are utilising its potential to the greatest extent possible. I have a feeling that they'll need all the help they can get!

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GUEST COMMENT

THOMAS SCHEURING
CEO, DECHEMA AUSSTELLUNGS-GMBH



A global forum for a global industry – if I had to describe AICHEMA in as few words as possible, this could be one way to do it. The process industries – chemicals, pharmaceuticals, food – are global players, tackling global challenges, and their solutions derive from global collaboration.

Raw material streams, products and technologies are traded all around the world, and all stakeholders profit from this. One reason for their global reach is that the process industries serve the most elementary needs of every citizen across the world. For example, thanks to agrochemicals, hunger in the world can be fought successfully. Industrial water treatment ensures that stress on natural resources is minimised, up to a point where a plant's water supply is completely self-sufficient, described by the 'zero liquid discharge' concept. The pharmaceutical industry develops plants that can be set up in any corner of the world to produce medication or vaccines customised to local requirements. New fuels, one day may even be made from CO₂ with the help of renewable energy, enable mobility. And lightweight materials and highly efficient processes help to reduce energy consumption.

In science, as well as in industry, work teams are diverse, and many research projects reach well beyond national and even continental borders. Thanks to digital communication, working groups can share and discuss their results in real time. Despite these possibilities, scientists still travel, visit other laboratories, make internships or spend their whole career moving from one continent to the other. Scientific curiosity does not end at the laboratory door. From collaboration that takes different perspectives into account, great

ideas are often born, which can then be developed further.

Many of these ideas can be seen and touched at one of

the approximately 3800 stands at AICHEMA 2018.

Building bridges is one of our aims. Not only between countries or regions, but also between disciplines: engineers, chemists, biotechnologists,

scientists, technology developers and users meet at AICHEMA. If you are looking to build a plant, AICHEMA is a one-stop shopping mall where you can find everything from the filter and the pump to the automation concept and the sensors to monitor your process. Thanks to the sheer size of the exhibition, you can also dive deeply into one section – visitors have been known to spend the whole week in Hall 8 where the world's largest exhibition of pumps, compressors and valves is an integral part of AICHEMA. And if you want to know what is on the horizon, visitors can listen in to some

“If you are looking to build a plant, AICHEMA is a one-stop shopping mall where you can find everything from the filter and the pump to the automation concept and the sensors to monitor your process.”

of the approximately 800 presentations in the lecture halls and learn what is on the way to the exhibition halls in 2021. Topics related to downstream oil and gas processing cover anything from alloys for steam cracking furnace coils to process monitoring in the refining industry.

Meeting people and discussing new ideas is something that works much better in person than in a blog or discussion forum on the internet. So, pack comfortable shoes, plan your visit and join us from 11 – 15 June 2018 in Frankfurt. True to our slogan: Be informed. Be inspired. Be there.

A person stands on a small rock in the foreground, looking up at a massive, jagged rock formation that dominates the right side of the frame. The sky is dark blue with numerous bright, diagonal streaks of light, suggesting a long-exposure photograph of stars or meteors. The overall mood is one of vastness and aspiration.

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WORLD NEWS

UAE | ADNOC announces plans to become a key downstream player

The Abu Dhabi National Oil Co. (ADNOC) has unveiled plans to invest AED 165 billion (US\$45 billion) alongside its partners, over the next five years, to become a leading global downstream player. The investment will allow the company to stretch the value of every barrel it produces to the benefit of ADNOC, its partners and the UAE.

The plans were unveiled at the ADNOC Downstream Investment Forum. The investment programme will underpin a new downstream strategy to significantly expand ADNOC's refining and petrochemical operations at Ruwais, and undertake highly targeted

overseas investments to secure greater market access.

Building on the existing strengths and competitive advantages of the Ruwais Industrial Complex, ADNOC will create the world's largest and most advanced integrated refining and petrochemicals complex. Through a combined programme of strategic partnerships and investment, the company will increase its range and volume of high-value downstream products, secure better access to growth markets globally, and create a manufacturing ecosystem in Ruwais that will significantly stimulate in-country value creation, private sector growth and employment.

USA | Cheniere continues construction at CCL Project

Cheniere Energy Inc's board of directors has made a positive final investment decision (FID) regarding Train 3 at the company's Corpus Christi liquefaction project (CCL Project). The company plans to issue a full notice to proceed to Bechtel Oil, Gas and Chemicals Inc. to continue construction, which began in late 2017 under limited notice to proceed. This represents

the first FID on new liquefaction capacity in the US since 2015.

The CCL Project is a three-train liquefaction project. Each train is expected to have a nominal production capacity, which is prior to adjusting for planned maintenance, production reliability, and potential overdesign, of approximately 4.5 million tpy of LNG.

USA | Total, Borealis and NOVA Chemicals close on petrochemicals JV

After receiving all of the required regulatory approvals, Total S.A., Borealis AG and NOVA Chemicals Corp. have closed on their joint venture (JV) in petrochemicals on the US Gulf Coast.

The JV company, named Bayport Polymers LLC (Bay-Pol), is 50% owned by Total and 50% owned by a JV between Borealis and NOVA Chemicals, Novealis Holdings LLC.

The Bay-Pol JV assets include: the under-construction 1 million tpy ethane steam cracker in Port Arthur, Texas; Total's existing polyethylene 400 000 tpy facility in Bayport, Texas; and a new 625 000 tpy Borstar® polyethylene unit at Total's Bayport site, subject to further approvals.

Diane Chamberlain has been appointed President of Bay-Pol. She said: "We're excited for the future of our new company. The partnership between Total, Borealis and NOVA Chemicals will create a major player in the US polyethylene market [...] We have a great opportunity to take advantage of low-cost feedstocks in the US and deliver quality products that respond to the growing global demand for plastics."

Pakistan | PARCO awards TechnipFMC a refinery contract

Pak-Arab Refinery Ltd (PARCO) has awarded TechnipFMC a project management consultancy (PMC) services contract to carry out the management of pre-engineering, procurement and construction (pre-EPC) activities for a grassroot, fully integrated, deep conversion refinery that will be constructed near Karachi.

The project will be managed and operated by wholly-owned subsidiary, PARCO Coastal Refinery Ltd (PCRL). When completed the facilities will comprise a modern, deep conversion refinery with a capacity of 250 000 bpd, supported by associated marine loading facilities. It will be Pakistan's largest

refinery and serve the rapidly growing domestic markets for refined products.

The agreement was signed on 16 May by Tariq Rizavi, CEO of PCRL, and Riccardo Moizo, Senior Vice President – Project Management Consultancy of TechnipFMC.



WORLD NEWS

IN BRIEF

GERMANY

ExxonMobil Catalysts and Licensing LLC and BASF Corp. have signed an alliance agreement to jointly develop new gas treating solvents and process technologies for use in natural gas processing and petroleum refining. Under this new agreement, BASF will market and license technologies developed from this collaboration, along with FLEXSORB™ and OASE® technologies.

USA

Cureton Midstream LLC will use Honeywell Connected Plant to provide prescriptive monitoring of its UOP Russell gas processing plant in Weld County, Colorado. The plant is designed to cryogenically extract 99% of ethane and 100% of propane from natural gas supplied by producers in the Niobrara basin.

ITALY

Esso Italiana has signed an agreement for the sale of its Augusta refinery, three fuel terminals in Augusta, Palermo and Naples, and associated pipelines, to Sonatrach. Esso Italiana and ExxonMobil will enter into multi-year commercial and technology agreements with Sonatrach for refinery products, including Group I base stocks and waxes, as well as the operation, improvement and use of the Augusta, Naples and Palermo terminals.

USA

Caliche Development Partners has executed a long-term storage services agreement for ethylene in its Beaumont, Texas, located cavern. The company will provide firm storage service in a substantial portion of the salt cavern for its customer's ethylene and derivative operations in the Golden Triangle area, beginning in 3Q18.

Saudi Arabia | WorleyParsons wins GES contract

WorleyParsons has been awarded a General Engineering Service (GES) contract by Yanbu Aramco Sinopec Refining Co. Ltd (YASREF) to help optimise the production of its facilities.

YASREF operates a full-conversion refinery that covers approximately 5.2 million m² in the Yanbu Industrial

City. It is the key anchor project in Yanbu.

YASREF uses 400 000 bpd of Arabian heavy crude oil to produce premium transportation fuels, as well as high-value refined products for both international and domestic markets. It became operational in September 2014.

India | Air Products unveils new gas complex

Air Products has inaugurated its new industrial gas complex within the Integrated Refinery Expansion Project (IREP) of the BPCL Kochi Refinery. The company has invested several hundred million dollars for the build-own-operate (BOO) project – the largest of its kind in India in terms of investment.

The Kochi Industrial Gas Complex, which generates hydrogen, nitrogen, oxygen, and steam, is key for BPCL's IREP to manufacture auto-fuels complying with Euro IV/Euro V specifications. The industrial gases manufactured at the complex also enable BPCL to increase refining capacity by nearly two-thirds, from

190 000 bpd to 310 000 bpd, while producing cleaner fuels through upgraded fuel specification.

Air Products teams located across four countries (India, the UK, the Netherlands, and the US) worked on the Kochi project and built on more than 15 acres of land, leased from BPCL.

A unique highlight of the plant is that the gas turbine is integrated into the design of the twin steam methane reformers. These are the first twin steam methane reformers designed and built by Air Products with a combined capacity of 16.4 tph of hydrogen production.

Worldwide | ExxonMobil sets greenhouse gas reduction targets

ExxonMobil has announced greenhouse gas reduction measures that it expects will lead to significant improvements in emissions performance by 2020. The company intends to reduce oil and gas methane emissions by 15% compared to 2016 and flared gas volumes by 25% compared to 2016 across its global oil and gas operations by 2020. The company also announced its intention to improve its energy efficiency in refining and chemical manufacturing facilities.

While the company has achieved a 10% improvement in energy efficiency across its global refining operations following an effort launched in 2000, further efforts to reduce greenhouse gas emissions will target the company's global refining and chemicals manufacturing network. Advanced efficiency technologies and techniques have helped ExxonMobil's chemical business reduce its net greenhouse gas emissions intensity by nearly 7% since 2013.

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WORLD NEWS

IN BRIEF

CHINA

China National Offshore Oil Corp. (CNOOC) and Shell Nanhai B.V. have officially started-up the second ethylene cracker at their Nanhai petrochemicals complex in Huizhou, Guangdong Province. The new ethylene cracker increases ethylene capacity at the complex by approximately 1.2 million tpy, more than doubling the capacity of the complex, and benefits from a deep integration with adjacent CNOOC refineries.

INDONESIA

Through its subsidiary INPEX Masela Ltd, INPEX Corp. has awarded KBR Inc. a pre-front-end engineering and design (pre-FEED) for the Abadi onshore LNG project. Under the contract, KBR will provide a pre-FEED package, utilising its proven design and execution methodologies. The work will be performed from KBR's Jakarta office, which will provide services including site master plan development, scope of work for the FEED phase, as well as an EPC schedule and cost estimate.

RUSSIA

With the loading of eight custom-made Damen tugs, Combi Lift has reached a milestone in the Gazprom Amur Gas Processing Plant (GPP) Project. This officially marks the transition between the project planning and implementation stages. Combi Lift, contracted by the Linde Group, chose to cooperate with SAL Heavy Lift on this project.

USA

The first commercial start-up of Clariant's OleMax 260 has been successfully achieved at the new ethylene production plant of The Dow Chemical Co. in Freeport, Texas. This catalyst was developed specifically for ethylene producers with 'front-end' process configurations to increase yields and profits, while helping to ensure safe and more sustainable operation.

Oman | Total to develop natural gas resources in Oman

Total has signed a Memorandum of Understanding (MoU) with the government of Oman to develop natural gas resources in the country. This MoU covers both upstream and downstream businesses.

Total and Shell will develop several natural gas discoveries in the Greater Barik area on onshore Block 6 with respective shares of 25% and 75%, as per the agreement between both companies and before possible State back-in, with the objective of an initial gas production of approximately 500 million ft³/d and

a potential to reach 1 billion ft³/d at a later stage.

Total will use its equity gas entitlement as feedstock to develop a regional hub for LNG bunkering service in Oman, which will supply LNG as a fuel to marine vessels. This will be achieved thanks to a new small-scale modular liquefaction plant, to be built in Sohar port. The plant will comprise a train of approximately 1 million tpy and will offer the flexibility for expansion as required by the development of the LNG bunkering market.

Argentina | Trafigura acquires downstream assets

The Trafigura Group Pte Ltd has acquired the majority of Pampa Energia SA's downstream assets. These assets include more than 250 service stations and the Ricardo Elicabe refinery (BBR), located in Bahia Blanca.

Trafigura's current operations in Argentina include a fluvial fleet and the Campana Terminal, which supplies

the Argentinian, Paraguayan and Bolivian markets with diesel and gasoline via the Parana River. It is also rapidly developing a network of retail service stations across Argentina under the Puma Energy brand.

The transfer of the assets and rebranding of the 250 service stations will be progressive and rolled out over the coming months.

Germany | BP selects hte for catalyst tests

hte – the high throughput experimentation company – has been selected by BP to evaluate commercial catalysts for both naphtha reforming and hydrocracking applications using high throughput technology under commercially-relevant conditions for its refineries.

BP selected hte for the evaluation study to benchmark commercial

naphtha reforming and hydrocracking catalysts and compare their performance against incumbent catalysts. The resulting testing programme will provide BP with the data to make selections for its upcoming naphtha reforming and hydrocracking catalyst change-outs.

The overall aim of both projects is to measure activity, yields and stability.

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WORLD NEWS

DIARY DATES

11 - 13 June 2018

ILTA International Operating Conference & Trade Show

Houston, Texas, USA
www.ilta.org/aocfs

11 - 15 June 2018

ACHEMA 2018

Frankfurt, Germany
www.achema.de

12 - 14 June 2018

Global Petroleum Show 2018

Calgary, Canada
www.globalpetroleumshow.com

25 - 29 June 2018

World Gas Conference 2018

Washington DC, USA
www.wgc2018.com

13 - 14 September 2018

11th EFRC Conference

Madrid, Spain
www.recip.org

17 - 20 September 2018

Gastech

Barcelona Spain
www.gastechevent.com

18 - 20 September 2018

Turbomachinery & Pump Symposia

Houston, Texas, USA
tps.tamu.edu

26 - 27 September 2018

Tank Storage Asia

Singapore
www.tankstorageasia.com

9 - 11 October 2018

Asia Downstream Week

Bangkok, Thailand
www.europetro.com

12 - 15 November 2018

ADIPEC

Abu Dhabi, UAE
www.adipec.com

1 - 5 April 2019

LNG 2019

Shanghai, China
www.lng2019.com

USA | Bilfinger Westcon selected for Braskem polypropylene project

Braskem and The Linde Group have selected Bilfinger Westcon Inc. as their lead mechanical subcontractor for Braskem's new North American polypropylene (PP) production line, named Delta.

Linde is the lead engineering, procurement and construction (EPC) contractor for the PP production line.

Braskem has committed up to US\$675 million towards the design and construction of the Delta line, which is being constructed next to the company's existing production facilities in La Porte, Texas. With the initial steel erection phase now

underway, the final phase of main construction remains on track and targeted for 1Q20. The new plant will have a production capacity of 450 000 tpy.

As the lead mechanical subcontractor on the project, Bilfinger Westcon will be responsible for the installation of structural steel, piping, and industrial process equipment through the completion of the facility construction. The line will represent additional production capacity of homopolymers, random copolymers, impact copolymers, and reactor thermoplastic polyolefins (TPOs).

Algeria | Total and Sonatrach ink agreement for petrochemical project

Total has signed an agreement with Sonatrach to launch engineering studies for a petrochemical project in Arzew.

The project includes a propane dehydrogenation (PDH) unit and a polypropylene (PP) production unit with an output capacity of 550 000 tpy. The project represents an investment of approximately US\$1.4 billion by the two partners (Sonatrach 51%, Total 49%), who are planning to start the front-end engineering and design (FEED) this

summer, subject to approval by the relevant Algerian regulatory authorities.

The facility will valorise propane, produced in large quantities locally, by transforming it into PP, a plastic for which demand is growing strongly. It will supply local and Mediterranean demand, and Total will be responsible for the commercialisation of the rest of the production in Europe, where it will leverage its market expertise to the benefit of both partners.

USA | JGC and S & B form partnership

JGC Corp. and S & B Engineers and Constructors Ltd have signed a framework agreement to form a strategic partnership to provide engineering, procurement and construction (EPC) services for projects within the US.

The partnership covers a full range of lifecycle services for the oil

and gas, petrochemicals, and chemicals markets, including preliminary feasibility studies, front-end engineering and design (FEED), EPC, and project management. JGC and S & B have previously executed several successful EPC projects on the Gulf Coast.

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MERICHEM COMPANY

Nancy D. Yamaguchi, Contributing Editor,
discusses the future of Europe's oil sector.



A NEW



Western Europe is widely viewed as a long-established grouping of mature economies that are technologically, culturally and politically advanced. This article focuses on the region's energy market, which has changed enormously in response to global conditions and pressures from both within and from outside of the region.

Still evolving

Outside of Europe, many people would be puzzled to identify the countries in the region, to place them within their proper boundaries, and to determine their memberships in the numerous overlapping international groupings, including the European Union (EU), the European Free Trade Association (EFTA), the European Economic Area (EEA), the Eurozone, as well as the Organisation for Economic Co-Operation and Development (OECD).

The emergence of new political and economic systems is having a massive impact on the European energy sector. Many Eastern Europe and Baltic States are now members of the EU. They use the Euro as their currency, but their energy infrastructure and markets may reflect former affiliations with the Former Soviet Union. Russia remains a key source of crude oil and natural gas to many of these countries, and Russian engineering built many pipelines, terminals and refineries along the way. The country maintains influence on some European countries via its ability to control the flow of resources.

A core group within Europe is OECD Europe, which was established in 1960 with the membership of 18 European countries plus the US and Canada. The organisation was dedicated to promoting economic development and most of the members were successful in this aim. There are now 35 members in Europe, North America, South America, and the Asia-Pacific region.

The OECD Europe countries are members of the EU, but the reverse is not always the case. For example, Iceland, Norway, and Switzerland are OECD members, but they are tied together economically via the EFTA, not the EU. Norway's absence from the EU can complicate European oil data, since it is the largest oil producer in Europe. Within the Baltic States, Estonia and Latvia are members of both the OECD and the EU, but Lithuania is an EU member outside of the OECD.

In 2007, Bulgaria and Romania joined the EU, while Croatia joined in 2013. These countries are not in the OECD. There are currently five countries seeking to join the EU: Turkey, the Republic of Macedonia, Albania, Montenegro and Serbia. Meanwhile, the UK voted to leave the EU in its 2016 referendum. The Brexit 'divorce' details are complex and still under construction.

Is Europe's situation and direction providing leadership for the western world? In the energy sector, at least, the regional industry seems beset from all sides, with energy providers seeking to expand market share in Europe. To the south are the Middle East and Africa, with massive reserves of oil and gas. To the east are Russia and other CIS countries, some of which are greatly expanding their energy production and exports.

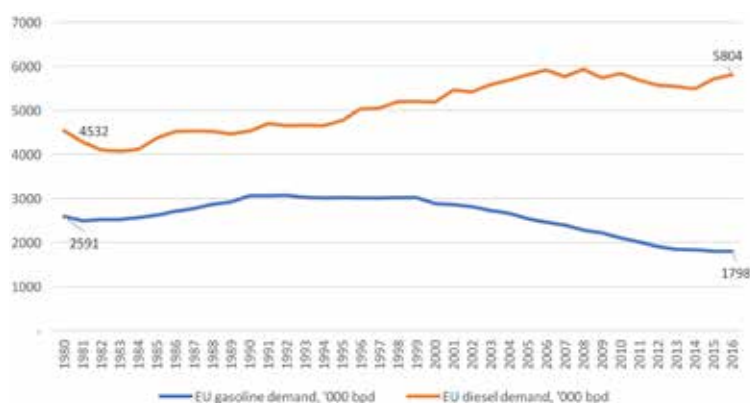


Figure 1. EU gasoline and diesel demand, '000 bpd (source: BP).

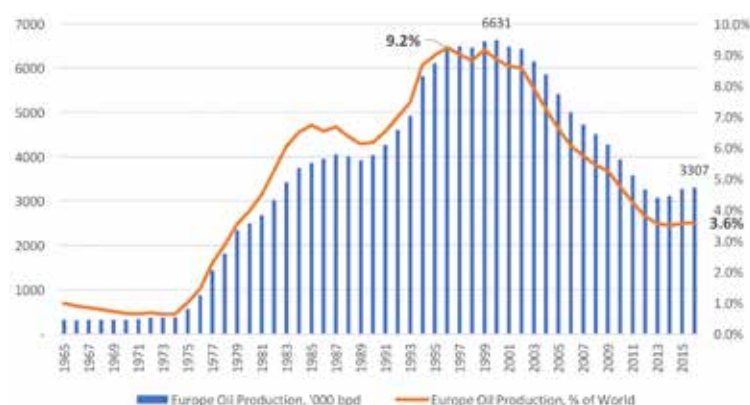


Figure 2. European oil production, '000 bpd, and percentage of global production (source: BP).

Russia is now a key member of the oil production cut agreement with OPEC, working to drain global oil stockpiles and drive up prices. As the dominant producer to the east of Europe, Russia has shown willingness to use its energy exports to promote its political aims. Even the US is precociously ramping up oil exports. The shale boom and the relaxation of restrictions on crude oil exports propelled US crude exports to approximately 1.1 million bpd in 2017, nearly 0.3 million bpd of which went to Europe. These exporters value the European market, but Europe is working to move away from fossil energy.

European energy demand declines

The EU energy sector is facing a long-term decline in fossil energy demand. The downward trend would be even more dramatic without the new entrants to the EU since 2004. According to data published by BP between 1965 and 1975, European energy demand was growing at approximately 3.5% per year. The oil price shocks caused oil use to shrink in the early 1980s, but demand began to grow once again after prices collapsed in 1986. European oil demand grew sedately at rates averaging 0.7% per year between 1985 and 2005. Between 2006 and 2016, however, oil demand fell at an average rate of 1.7% per year. Coal consumption fell at an average rate of 3.1% per year. Even natural gas use, which had been promoted as a clean alternative to oil and coal, fell at an average rate of 1.3% per year. The bright spot of growth has been for alternative and renewable energy sources other than hydropower.

Within the oil sector, gasoline demand is declining, and it is assumed that the gasoline market will continue to shrink. Gasoline demand in the EU peaked at approximately 3.07 million bpd in 1992. Between 1990 and 2016, gasoline demand declined at an average rate of 2% per year. This demand fell to approximately 1.8 million bpd in 2016.

EU diesel demand grew at 1% per year from 1990 to 2016, increasing from approximately 4.5 million bpd in 1990 to 5.8 million bpd in 2016. As Figure 1 illustrates, however, the oil price spike of 2008 and the subsequent global economic recession derailed demand growth. During the period between 2008 and 2016, diesel demand shrank at an average annual rate of 0.3%, while gasoline demand shrank at a rate of 2.9% per year.

To place EU gasoline demand in context, the EU has a population of approximately 508 million, and a gasoline market size of 1.8 million bpd. The US has a population of 325.7 million and a gasoline market size of over 9.3 million bpd. Thus, on a per-capita basis, US consumers use eight times as much gasoline as their European peers.

The EU remains a large and important oil market, but it is viewed as a shrinking market. This makes it difficult to justify large investments in the fossil energy sector. Fuel quality regulation and the structure of demand offer additional challenges. It takes a highly sophisticated refinery to produce an output slate dominated by ultra-low sulfur diesel, with a declining share of gasoline and virtually no residual fuel oil. Many refineries have closed, as will be discussed throughout this article.

Dwindling oil production and rising imports

European crude oil production has been following a 'Hubbert Peak' bell-shaped curve trend (Figure 2). Production grew from approximately 0.3 million bpd in the early 1960s to a peak of 6.6 million bpd in 1999 – 2000. It then slid to 3.1 million bpd in 2013 before rebounding slightly to 3.3 million bpd in 2016. This includes production from Norway, a non-EU member that is Europe's largest crude producer, and the UK, Europe's second-largest producer. The International Energy Agency (IEA) places Norwegian production at 1.97 million bpd in 2017 and UK production at 1.02 million bpd. The other producers of note are Denmark (142 000 bpd in 2016), Italy (79 000 bpd in 2016), and Romania (79 000 bpd in 2016).

In 1996, Europe accounted for 9.2% of global crude production. This share fell to 3.6% in 2016.

Europe is a major importer of both crude oil and refined products. Figure 3 provides details on crude oil imports by source in 2016, per BP. Of the total 499.4 million t, nearly half was imported from Russia and other CIS countries. The Middle East was the source of 25% of Europe's crude import, followed by Africa (21%) and the Americas (6%).

Europe imported 1.1 billion t of refined product in 2016 (Figure 4). The sources were diverse: 33% from Asia and the

Latest News



HYDROCARBON ENGINEERING

➤ VENTURE GLOBAL LNG TO SUPPLY LNG TO BP

Venture Global Calcasieu Pass LLC (a subsidiary of Venture Global LNG Inc.) and BP have entered into a sales and purchase agreement for the supply of 2 million tpy of LNG from the Venture Global Calcasieu Pass LNG export facility, which is currently under development in Cameron Parish, Louisiana, US. Under the agreement, BP will purchase LNG on a free on board basis for a 20-year term, starting from the commercial operation date of the LNG export facility, which is currently expected in 2022.

➤ CEPESA AND ADNOC SIGN PROJECT DEVELOPMENT AGREEMENT

The Abu Dhabi National Oil Co. (ADNOC) has signed a project development agreement with Cepsa of Spain for a new, world-scale linear alkylbenzene (LAB) facility in ADNOC's refining and petrochemicals complex in Ruwais, UAE. This LAB project is one of a number of initiatives to be executed as ADNOC looks to significantly enhance and expand its refining operations and capabilities to support its downstream plans.

➤ CHEVRON AND NOVVI PARTNER ON BASE OIL TECHNOLOGIES

Amyris Inc. and Chevron Products Co., a division of Chevron U.S.A. Inc., have announced that Novvi LLC and Chevron have entered into an agreement to jointly develop and bring to market novel renewable base oil technologies. Terms of the transaction have not been disclosed.

➤ MAMMOET COMPLETES PROJECT AT US REFINERY

Mammoet has constructed and safely manoeuvred two CC8800 cranes for the installation of large sections of furnaces in an 86-year old refinery in Texas, US. The company helped to cut the project's duration by more than one month and thus get the refinery back online sooner.

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Pacific, 28% from the Americas, 19% from the Middle East, 16% from Russia and other CIS countries, and 4% from Africa.

More recently, the US has expanded its presence in the global export market. The shale boom added over 4.3 million bpd of crude supply to the US between 2008 and 2017. Refinery utilisation rates rose dramatically in US areas with surplus light tight oils (LTOs) from shale plays, and the excess product was exported.

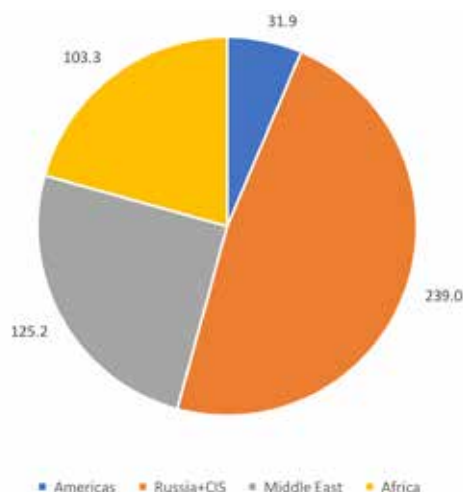


Figure 3. Europe crude imports 2016, million t (source: BP).

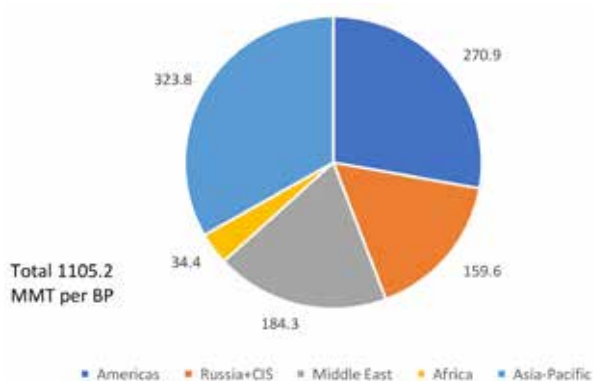


Figure 4. Europe product imports 2016, million t (source: BP).



Figure 5. Growth in US crude and product exports to Europe, '000 bpd (source: US Energy Information Administration).

Figure 5 illustrates the growth in US refined product and crude exports to Europe. In 2004, the US exported around 0.2 million bpd of product to Europe. This grew to 0.73 million bpd by 2015. At the end of 2015, the US eased its 1970s-era restrictions on crude exports. When the restrictions were lifted, crude oil exports to Europe rose to nearly 0.3 million bpd in 2017.

European refining: losing ground in the global context

While many European countries have found common ground for economic cooperation, the refining industry remains one where countries and companies largely go their own way. Rationalising European refining has been a decades-long battle, and this is likely to continue.

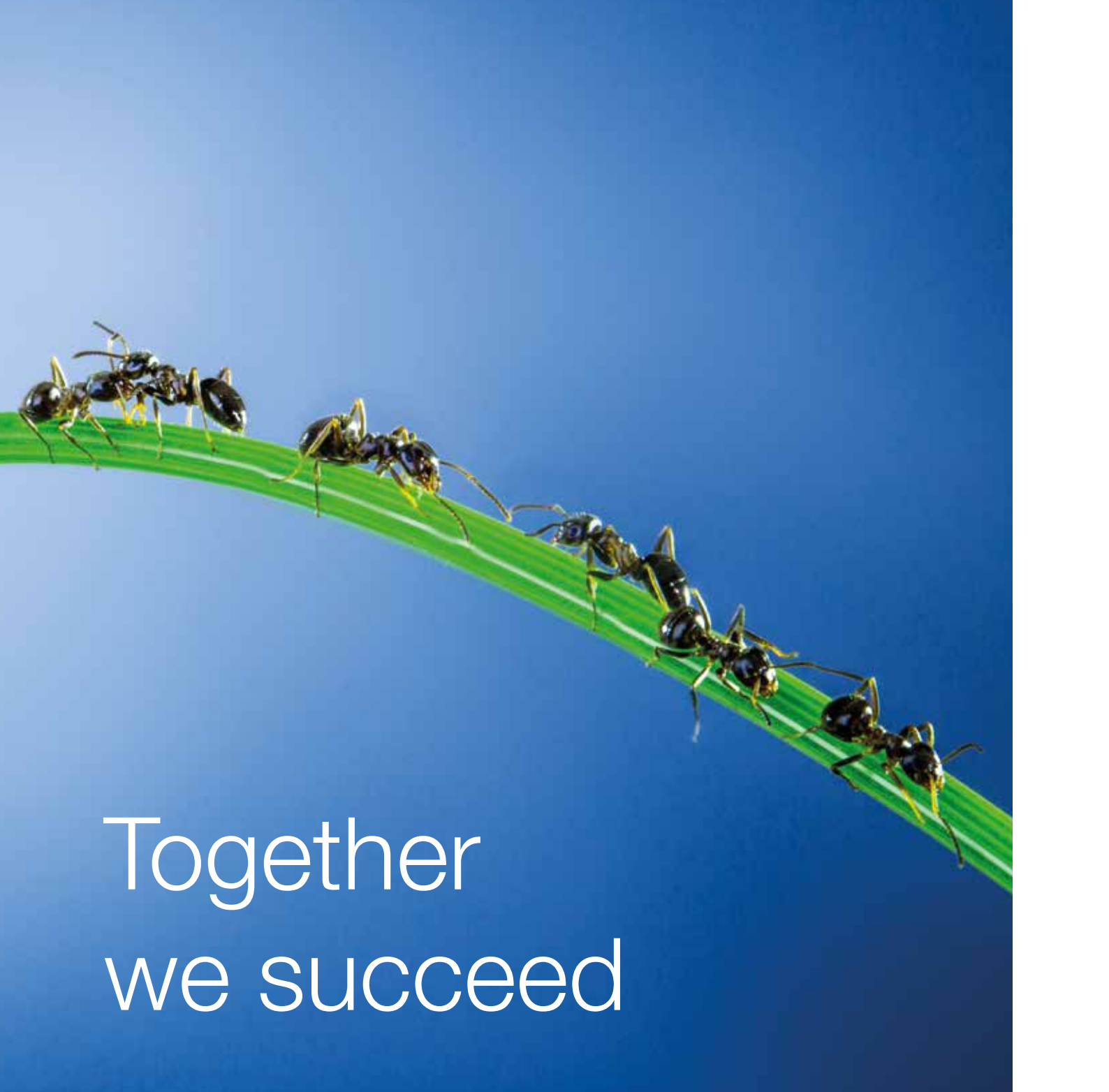
Figure 6 shows the rise and fall in European crude refining capacity. Globally, refineries were built swiftly in the 1960s and 1970s. In 1965, Europe's crude capacity was approximately 8.7 million bpd. This soared to 22.9 million bpd by 1976. The oil price shocks of the 1970s then caused oil demand to collapse. Many refineries were mothballed or closed, including ones that had been newly built. Europe's industry suffered greatly during the years of global overcapacity. Between 1976 and 1986, European capacity dropped by nearly 5.7 million bpd. Another 0.8 million bpd closed between 1986 and 1993.

During this time, Saudi Arabia launched a programme of export-oriented refinery expansion. The rationale was that crude oil exporting countries could capture more value-added by processing their own raw materials. Although the Asia Pacific market was the primary target, Europe was viewed as the secondary outlet. This placed additional pressure on European refineries, particularly those without access to inexpensive crude oil feedstocks.

Europe's refineries have been pressured from all sides. In 1991, the Soviet Union was dissolved, causing upheaval in Central Asia and Eastern Europe. Oil production plunged. As Russia and the newly-emerged CIS countries began to recover, many began to rebuild and modernise their refineries, both for domestic markets and for export markets.

In Asia, the oil demand boom was accompanied by the world's largest programme of refinery expansion. Between 1996 and 2016, 14.4 million bpd of refinery capacity was added in Asia – more than the capacity of the entire EU. Many new Asian refineries are export-oriented, designed to produce ultra-low sulfur fuels that are compatible with European specifications.

Europe's refinery capacity stagnated, remaining in the range of 16.2 million bpd – 17.2 million bpd for many years. However, investments are continually required to improve the yield of higher-quality transport fuels. European governments have also begun to require more efficient engines with lower emission levels, and these vehicles require better quality fuels. The vehicle and fuel standards became known as Euro standards, and they quickly spread around the world. The phase-in schedule varied by fuel, location, and vehicle types. As a rough chronology, however, Euro 1 and Euro 2 standards were adopted in the 1990s, Euro 3 followed in the year 2000, Euro 4 arrived in 2005, and Euro 5 was adopted in 2008 – 2009. For new European vehicles, Euro 6 standards were introduced in September 2015 to further tighten vehicle emissions.



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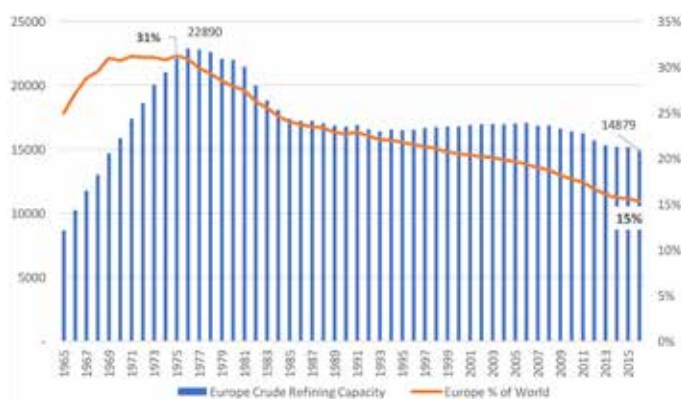


Figure 6. Europe's refining capacity, '000 bpd, and percentage of world (source: BP).

Europe's refining companies invested steadily to comply with Euro standards. Market demand, however, was not growing. The oil price spike and the global economic recession in 2008 caused a drop of approximately 2.2 million bpd of oil demand between 2008 and 2014, before demand recovered modestly in 2015 – 2016. This hastened the process of refinery closures. Europe's refining capacity fell by nearly 2 million bpd between 2008 and 2016. Europe's role in global refining has fallen dramatically. In 1975, the region was the site of 31% of the world's refinery capacity. In 2016, this had been reduced to 15%.

European refinery changes and closures

Europe's refining sector has been plagued by overcapacity and poor profitability. Market analysts have continually pointed to this overcapacity and recommended that certain refineries be closed. The process has taken years, since it is always easier to recommend that someone else close a refinery rather than it is to close your own. The decision to close a refinery is never an easy one. Most refineries try to hold out and await better times, or to wait for a competitor to close.

There have been few refinery expansions, with the notable exception of Repsol's expansion in Cartagena, Spain, where construction was launched in 2011. The project more than doubled the refinery's capacity, from 100 000 bpd to 220 000 bpd. Product yields and quality were improved by adding a hydrocracker and a coker.

Over time, however, many European refineries were unable to remain competitive. The following is a brief chronology of changes in European capacity since 1993, compiled from various sources. These include closures, partial closures, or changes in function. Some refineries changed ownership, but at times the new owners were not able to fully upgrade or expand as originally planned:

- Agip Raffinazione SpA, Rho, Milan, Italy, 80 000 bpd, closed (1993).
- Kuwait Raffinazione E Chimica, Naples, Italy, 100 000 bpd, closed (1993).
- Bosanski, Brod, Bosnia-Herzegovina, destroyed by war; reopened in 2000 with Russian assistance (1994).
- Hydrierwerk Zeitz GmbH, Zeitz, Germany, 74 000 bpd, closed (1995).
- Mobil Oil AG, Wörth, Germany, 105 000 bpd, closed (1995).
- Leuna Raffineriegesellschaft, Leuna, Germany, 100 000 bpd, closed (1997).
- Gulf Oil, Milhaven, Wales, UK, 112 000 bpd, closed (1997).
- Addinol Mineralöl GmbH, Krumpa, Germany, 118 000 bpd, operates as a lubricant oil plant (1998).
- Shell UK Ltd, Shell Haven, UK, 92 000 bpd, closed (1999).

- Norske Shell AS, Sola, Norway, 53 000 bpd, closed (2000).
- MOL Hungarian Oil and Gas Co., Zalaegerszeg, Hungary, 10 000 bpd, operates as an asphalt plant (2001).
- Koramo Kolin, Kolin, Czech Republic, does not process crude, operated as a lubricant oil plant but this shut down (2008).
- MOL Hungarian Oil and Gas, Tiszaujvaros, Hungary, does not process crude (2008).
- Total SA, Dunkirk, France, 137 000 bpd, shut down (2009).
- Petroplus International NV, Teesside, England, UK, 100 000 bpd, operating as a storage and marketing facility (2009).
- Petroplus Reichstett, France, 85 000 bpd, shut down (2010).
- ConocoPhillips, Wilhelmshaven, Germany, 260 000 bpd, shut down (2010).
- Petroplus Holdings AG, Cressier, Switzerland, 60 000 bpd, shut down (2011).
- Tamol Raffinazione SpA, Cremona, Italy, 94 000 bpd, converted to a storage facility (2011).
- Unipetrol, Paramo, Czech Republic, 20 000 bpd, shut down (2012).
- Arpechim SA/Petrom, Pitesti, Romania, 70 000 bpd, shut down (2012).
- Petroplus, Petit Couronne, France, 162 000 bpd, shut down (2012).
- Petroplus, Coryton, England, UK, 220 000 bpd, shut down (2012).
- ExxonMobil, Fawley, England, UK, reduced capacity by 40 000 bpd (2012).
- Total/ERG, Rome, Italy, 86 000 bpd, shut down (2012).
- Eni SpA, Porto Marghera, Italy, 80 000 bpd, converted to a biorefinery (2013).
- Total SA, Gonfreville, France, 111 000 bpd capacity reduction (one of two crude towers) (2013).
- Deutsche Shell AG, Harburg, Germany, 110 000 bpd capacity reduction (2013).
- Italiana Energia E Servizi SpA, Mantova, Italy, 69 000 bpd, converting to a product logistics hub (2014).
- LyondellBasell Industries, Berre l'Etang, France, 105 000 bpd, initially mothballed, then converted to an oil terminal (2014).
- Murphy Oil Co., Milford Haven, Wales, UK, 135 000 bpd, converting to an oil terminal (2014).
- MOL Hungary, Mantua, Italy, 55 000 bpd, converting to an oil terminal (2014).
- Eni, Gela, Italy, 105 000 bpd, to be transformed to a 'Green Refinery' (2015).
- Total SA, La Mede, France, 158 000 bpd, converted to a biorefinery and an oil storage and trade terminal (2015).
- CEPISA, Tenerife, Spain, 87 000 bpd, shut down (2015).
- Total SA, Killingholme, South Humberside, England, UK, 222 000 bpd, closure of one distillation unit (2016).
- Eni, Gela, Italy, 105 000 bpd, to be transformed to a 'Green Refinery'. Legal issues in 2017 may close refinery entirely (2017).

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Fewer but stronger

This article has identified 36 European refineries that have either been closed, converted to other uses, or have had crude throughput reduced or eliminated. Table 1 looks more closely at refinery capacities in Europe's six largest refining countries. The table compares each country's crude distillation unit (CDU) capacity in 2001 with its capacity in 2017. CDU capacity was reduced in France, Germany, Italy, and the UK, while it was expanded in Spain and the Netherlands. In the Netherlands,

the refining industry has the advantage of location, tied with Rotterdam, Europe's largest port and oil terminal.

In total, CDU capacity fell from 10.78 million bpd in 2001 to 9.74 million bpd in 2017. The number of refineries fell from 69 in 2001 to 56 in 2017.

Meeting Euro standards has been a challenge for refineries. Producing ultra-low sulfur fuels has forced countries to increase their hydrotreating capabilities. Concurrently, crude capacity was reduced, causing the ratio of hydrotreating to

CDU capacity to increase. In 2001, hydrotreating capacity was listed at 5.8 million bpd, while CDU capacity was 10.78 million bpd – a hydrotreating-to-CDU ratio of 54%. By 2017, hydrotreating capacity had grown to 6.9 million bpd, while CDU capacity had fallen to 9.74 million bpd. The hydrotreating-to-CDU capacity ratio grew to 71%.

Conclusion

Europe's energy industry has been pressured by stringent regulations, external competition, falling production, and falling demand. Dozens of refineries have closed, cut back on crude throughput, or been transformed into terminals or biorefineries.

Europe's refining industry has made investments to comply with Euro standards. The remaining refineries are larger and sophisticated, but there are no plans to invest in new refineries, and additional capacity rationalisation is expected. Refineries and downstream assets also continue to change hands. Algeria's national oil company, Sonatrach, recently purchased ExxonMobil's refinery in Augusta, Italy, along with three terminals and associated pipelines. Despite the shrinking market, many foreign refiners are vying to export fuel to Europe. Some countries accelerated the adoption of Euro specification fuels for their domestic markets so they could also penetrate the EU market.

In time, would-be exporters may find the EU market changed beyond recognition. The EU is committed to fighting environmental degradation and reducing greenhouse gas emissions. It is significant that the world's milestone climate accord is called the Paris Agreement, adopted by consensus in 2012. Europe has dramatically reduced its carbon dioxide emissions (Figure 7). In 1965, the region contributed an estimated 29.4% of global carbon dioxide emissions. This share plummeted to 10.4% in 2016, and the EU has ambitious goals to continue on this path. France, for example, is determined to ban all use of coal for electricity generation, and eventually ban the use of gasoline and diesel vehicles.


Europe is a diverse grouping of countries that have united in many key ways to choose new paths. Perhaps the region will continue to set the path for the global energy sector. 

Table 1. Europe's largest refining countries focus on sulfur removal

	Crude distillation capacity (bpd)	Hydrotreating capacity (bpd)	CDU:HDT ratio (%)	Number of refineries
France 2001	1 895 473	928 607	49	12
France 2017	1 405 913	1 065 393	76	8
Gain/(loss)	(489 560)	136 786	27	(4)
Germany 2001	2 259 000	1 601 513	71	14
Germany 2017	2 188 984	1 958 614	89	13
Gain/(loss)	(70 016)	357 101	19	(1)
Italy 2001	2 359 100	1 072 310	45	17
Italy 2017	2 117 309	1 207 973	57	13
Gain/(loss)	(241 791)	135 663	12	(4)
The Netherlands 2001	1 203 842	651 470	54	6
The Netherlands 2017	1 213 092	783 241	65	6
Gain/(loss)	9250	131 771	10	n/a
Spain 2001	1 293 500	536 300	41	9
Spain 2017	1 427 500	827 630	58	9
Gain/(loss)	134 000	291 330	17	n/a
UK 2001	1 771 040	1 015 190	57	11
UK 2017	1 389 705	1 070 990	77	7
Gain/(loss)	(381 335)	55 800	20	(4)
Top six 2001	10 781 955	5 805 390	54	69
Top six 2017	9 742 503	6 913 841	71	56
Gain/(loss)	1 039 452	1 108 451	17	(13)

Note: author's calculations based on *Oil and Gas Journal* capacity figures

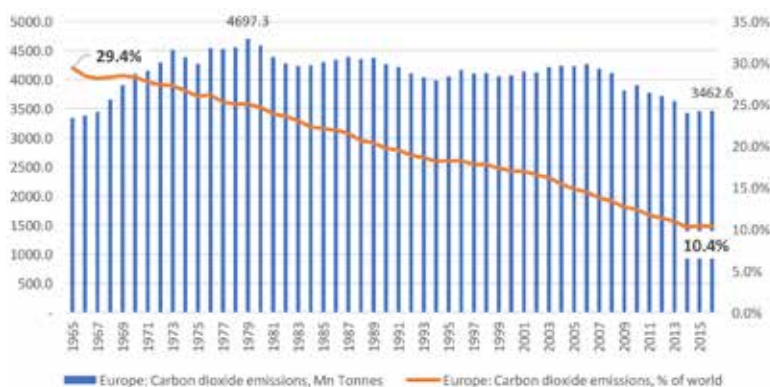


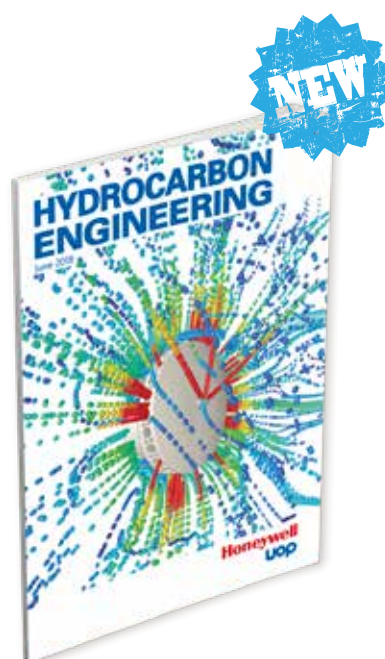
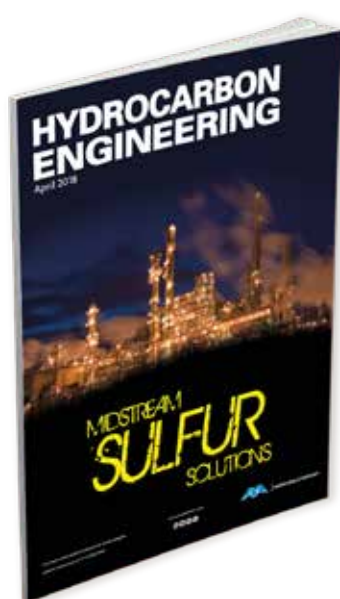
Figure 7. Europe's carbon dioxide emissions, million t, and percentage of world (source: BP).

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